

# An Introduction to Augmented Reality Research

Mark Billinghurst

mark.billinghurst@hitlabnz.org

HIT Lab (NZ), University of Canterbury

---

---

---

---

---

---

---

---

## Overview

- Introduction
- AR Technology – Displays + Tracking
- Interaction Techniques for AR
- Collaborative AR Interfaces
- Usability Testing
- Developing Applications with ARToolKit
- Research Directions

---

---

---

---

---

---

---

---

## A Brief History of AR (1)

- 1960's: Sutherland / Sproull's first HMD system was see-through



---

---

---

---

---

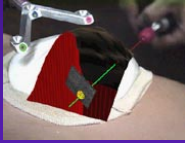
---

---

---

## Applications: medical

- "X-ray vision" for surgeons
- Aid visualization, minimally-invasive operations. Training. MRI, CT data.
  - Ultrasound project, UNC Chapel Hill.



Courtesy  
UNC  
Chapel  
Hill



---

---

---

---

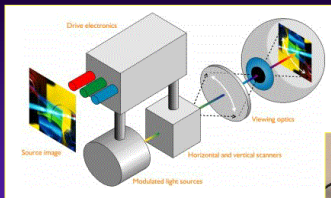
---

---

---

---

## The Virtual Retinal Display



- Image scanned onto retina
- [www.mvis.com](http://www.mvis.com)

---

---

---

---

---

---

---

---

## AR Interfaces as 3D data browsers

- 3D virtual objects are registered in 3D
  - See-through HMDs, 6 DOF optical, magnetic trackers
  - "VR in Real World"
- Interaction
  - 3D virtual viewpoint control
- Applications
  - Visualization, guidance, training



State, et al. 1996

---

---

---

---

---

---

---

---

## AR interfaces as context based information browsers

- Information is registered to real-world context
  - Hand held AR displays
    - Video-see-through (Rekimoto, 1997) or non-see through (Fitzmaurice, et al. 1993)
    - Magnetic trackers or computer vision based
- Interaction
  - Manipulation of a window into information space
- Applications
  - Context-aware information displays



Rekimoto, et al. 1997

---

---

---

---

---

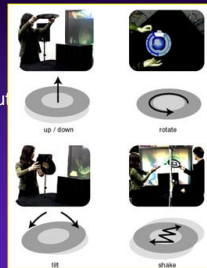
---

---

---

## ARGroove

- Collaborative Instrument
- Exploring Physically Based Interaction
  - Map physical actions to Midi output
    - Translation, rotation
    - Tilt, shake
- Time Multiplexed Interface
  - One physical object -> many commands



---

---

---

---

---

---

---

---

## Tangible AR: Generic Interface Semantics

- Tiles semantics
  - data tiles
  - operation tiles
    - menu
    - clipboard
    - trashcan
    - help
- Operation on tiles
  - proximity
  - spatial arrangements
  - space-multiplexed



Tiles, 2001

---

---

---

---

---

---

---

---

## Proximity-based Interaction

Operation		Result		
Menu operations				
	+		=	
Clipboard operations				
	+		=	
	+		=	
	+		=	

---

---

---

---

---

---

---

---

## Collaborative Augmented Reality

- Seamless Interaction
- Natural Communication
- Attributes:
  - Virtuality
  - Augmentation
  - Cooperation
  - Independence
  - Individuality



---

---

---

---

---

---

---

---

## AR Conferencing

- Moves conferencing from the desktop to the workspace



---

---

---

---

---

---

---

---

## A Wearable Information Space



Head Stabilized



Body Stabilized

- No additional input devices needed
- Users cannot be easily disorientated
- Maps to natural body motions
- Allows the use of spatial cues

---

---

---

---

---

---

---

---

## Developing an ARToolKit Application

### ● Basic Outline

- Step1. Image capture & display
- Step2. Marker detection
- Step3. Marker identification
- Step4. Getting 3D information
- Step5. Object Interactions
- Step6. Display virtual objects



---

---

---

---

---

---

---

---

## Technology

### ● Reality

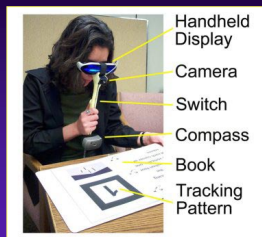
- No technology

### ● Augmented Reality

- Camera – tracking
- Switch – fly in

### ● Virtual Reality

- Compass – tracking
- Press pad – move
- Switch – fly out



---

---

---

---

---

---

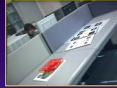
---

---

## Tracking Method

### Iterative Tracking Process

- Calculate camera pose from set of features in the image
- Use template matching to find set of features in next frame
  - Dynamic template generation
- Use normalized correlation value for template matching



---

---

---

---

---

---

---

---

## Hybrid User Interfaces



PERSONAL



TABLETOP



WHITEBOARD



MULTIGROUP



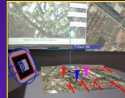
Private Display



Private Display  
Group Display



Private Display  
Public Display



Private Display  
Group Display  
Public Display

---

---

---

---

---

---

---

---